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Prioritizing Wildlife Taxa for Biological Diversity Conservation at the local scale

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Prioritizing Wildlife Taxa for Biological Diversity Conservation at the Local Scale

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ABSTRACT / We identified and ranked 108 resident and migratory wildlife taxa on John F. Kennedy Space Center (KSC) that were vulnerable to local, regional, or global extinction. We ranked taxa based on their vulnerability to extinction, their potential role for maintaining faunal integrity, and the relevance of KSC for maintaining their populations in the United States and Florida. Several taxa, not listed by agencies, were vulnerable to regional or global extinction. Many taxa not vulnerable to global extinction were vulnerable to local and regional extinction. Top predators were vulnerable to extinction because of small population size, isolation from other populations, and road mortality. Many taxa were dependent on habitat conditions at different geographic locations so that conservation required greater collaboration among land owners, managers, and researchers at local, regional, and global scales.

Conservation of biological diversity is a necessary part of natural resource management (Noss 1990). Biological diversity refers to ecosystem, community, species, and genetic diversity at global, national, regional, and local levels (Blockstein 1989). Conservation of biological diversity emphasizes diversity at regional scales, conservation of genetic variation, provisions for taxa to adapt and evolve, and ecosystem integrity (Frankel and Soule 1981, Noss 1990). "Taxa" here refers to species or subspecies.

Protocols are needed for biological diversity conservation at the local scale (DeFreese 1995, Swain 1995). To minimize extinction of many taxa, priorities are needed for monitoring and management. Detailed studies of taxa are often needed because their persistence can not always easily be predicted from vegetation composition or landscape patterns (Harris and Kangas 1988, Pulliam and others 1992, Breininger and others 1995). Our objectives are: (1) identify wildlife taxa that are potentially endangered globally, regionally, or locally (at KSC), and (2) rank taxa according to their degree of endangerment, their relevance for maintaining faunal integrity, and the significance of KSC in maintaining their populations in the United States and Florida. We also compare the findings to agency lists of endangered and threatened species and identify categories of taxa where agency lists are not sufficient.

KEY WORDS: Biological diversity; Endangered species; Conservation

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Study Area Description

Most of KSC is on Merritt Island National Wildlife Refuge and forms a barrier island complex with the adjacent Cape Canaveral Air Station (CCAS). Lands and estuarine lagoons of KSC comprise 57,000 ha located along the central east coast of Florida. KSC occurs within a biogeographic transition zone, having faunal and floral assemblages derived from temperate Carolinian and tropical/subtropical Caribbean biotic provinces (DeFreese 1995). Wildlife diversity on KSC results from many types of upland and wetland habitats and from a large number of migratory birds (Breininger and Smith 1990).

Scrub and pinelands are the dominant upland communities (Breininger and others 1995). A strip of coastal dune occurs adjacent to the Atlantic Ocean. Forests occur on higher areas among marshes and lower areas among scrub and pinelands. The Indian River Lagoon surrounds much of KSC and contains one of the richest estuarine faunas in the continental United States (DeFreese 1995). Fresh and salt marshes occur adjacent to the estuary and in low areas interspersed in scrub and pinelands. Most land near the KSC/CCAS barrier island complex is urban (Larson 1995).

Methods

Taxa that were ranked included endangered or threatened species and species of special concern listed by the US Fish and Wildlife Service (USFWS) (50 CFR 17.11 and 17.12) and Florida Game and Fresh Water Fish Commission. (FGFWFC) (Wood 1996). Other vul-

nerable taxa were identified using Florida natural areas inventory (FNAI) and scientific lists including Kale (1978), Burke and Humphrey (1987), Noss and Labisky (1990), Humphrey (1992), Moler (1992), and McCoy and Mushinsky (1992). Other resident populations of taxa with less than 500 adults on KSC were also considered vulnerable to extinction (see Frankel and Soule 1981).

Taxa were scored by summing points on: (1) their vulnerability to extinction, (2) the population's functional role at KSC, and (3) the relevance of KSC to populations of the taxa in the United States and Florida. The biological vulnerability score from Millsap and others (1991) was used as one measure of vulnerability at global and regional scales. Millsap's score was based on population size, population trend, changes in distribution, fecundity, and ecological specializations. The second vulnerability score for global and regional scales was based on the most vulnerable status from either USFWS, FGFWFC, and FNAI lists. Taxa classified as endangered or critically imperiled were given 30 points. Taxa classified as threatened or imperiled were given 20 points. Taxa of special concern or vulnerable were given 10 points.

The potential isolation of KSC populations and the population size of residents were used to score local-scale vulnerability to extinction. Amphibians, reptiles, and most mammals were assumed to have the potential for isolation due to surrounding waterbodies and urban areas (Harris 1984). Populations that might become isolated at KSC were given 30 points. Resident populations, whether permanent or seasonal, received emphasis over migratory transients. Taxa with breeding or winter resident population sizes of <500 adults were considered most vulnerable and were assigned 30 points. Taxa with resident populations of 500–5000 were assigned 20 points and taxa with >5000 residents were assigned 10 points. This was a rapid method to rank a large number of taxa that might be vulnerable to local extinction. More quantitative methods have been used to assess extinction threats (e.g., Mace and Lande 1991), but these methods require detailed demographic measurements and incorporate parameter uncertainties that may result in poor comparisons of extinction risk among taxa (Taylor 1994). Population sizes of taxa were derived from surveys and published estimates of territory size, home ranges, or densities that were applied to acreages of potential habitat (Breininger and others 1994).

Keystone taxa, which were assumed to have a functional role in maintaining faunal integrity, were given 30 points. Keystone taxa included top predators such as alligators, bobcats, large snakes, and large owls and hawks or taxa that provided large cavities or burrows important to other taxa (Whitcomb and others 1981, Wilcove and others 1986). The significance of KSC populations to Florida and US populations was used to score second and third categories of relevance. If KSC could provide habitat for at least 10% of the entire US population of a taxon or if KSC was one of the 10 largest US populations of the taxon, the taxon was scored 30 points. If KSC could provide for at least 10% of the Florida population or if KSC was one of the 10 largest Florida populations of the taxon, the taxon was assigned another 30 points.

Scores were totaled for each taxon. The highest score was divided by four to develop four levels of decreasing priority. Taxa were placed into levels according to their scores.

Results

One amphibian, 16 reptiles, 82 birds, and 10 mammals were potentially endangered on KSC (Appendix 1). Only 17 were federally listed and only 33 were state listed. Vulnerable taxa were 1/20 of the amphibians, 1/5 of the reptiles, 1/4 of the birds, and 1/4 of the mammals on KSC. KSC provided for significant populations in the United States for 13 taxa and significant populations in Florida for 32 taxa.

There were 63 taxa that had low (≤500) population sizes, 14 had moderate (501–5000) population sizes, and three had large populations. Eighteen taxa with low population sizes were potentially isolated from other populations. At least 60 potentially endangered taxa used KSC during only a portion of each year. Another 25 taxa included permanent resident taxa that often were supplemented by winter residents from other geographical areas. Nearly half of the birds and reptiles that were federally listed as endangered or threatened in Florida occurred on KSC.

The taxa that received the highest ranking were listed by either the USFWS or FGFWFC except for the east coast diamondback terrapin (Figure 1). Only 1/4 of the second highest ranked taxa were listed by USFWS and 1/2 by FGFWFC. Nearly 3/4 of this group were ranked by FNAI. Nearly 1/2 the taxa in the third highest group were not listed by USFWS, FGFWFC, or FNAI. The KSC populations of the highest ranked taxa were usually significant populations for Florida and the United States. Few top predators or other keystone taxa were among the highest ranked taxa. Only six of the 24 taxa that had potential functional roles in faunal integrity were listed by USFWS or FGFWFC. Nine of the taxa having potential roles in faunal integrity were poten-

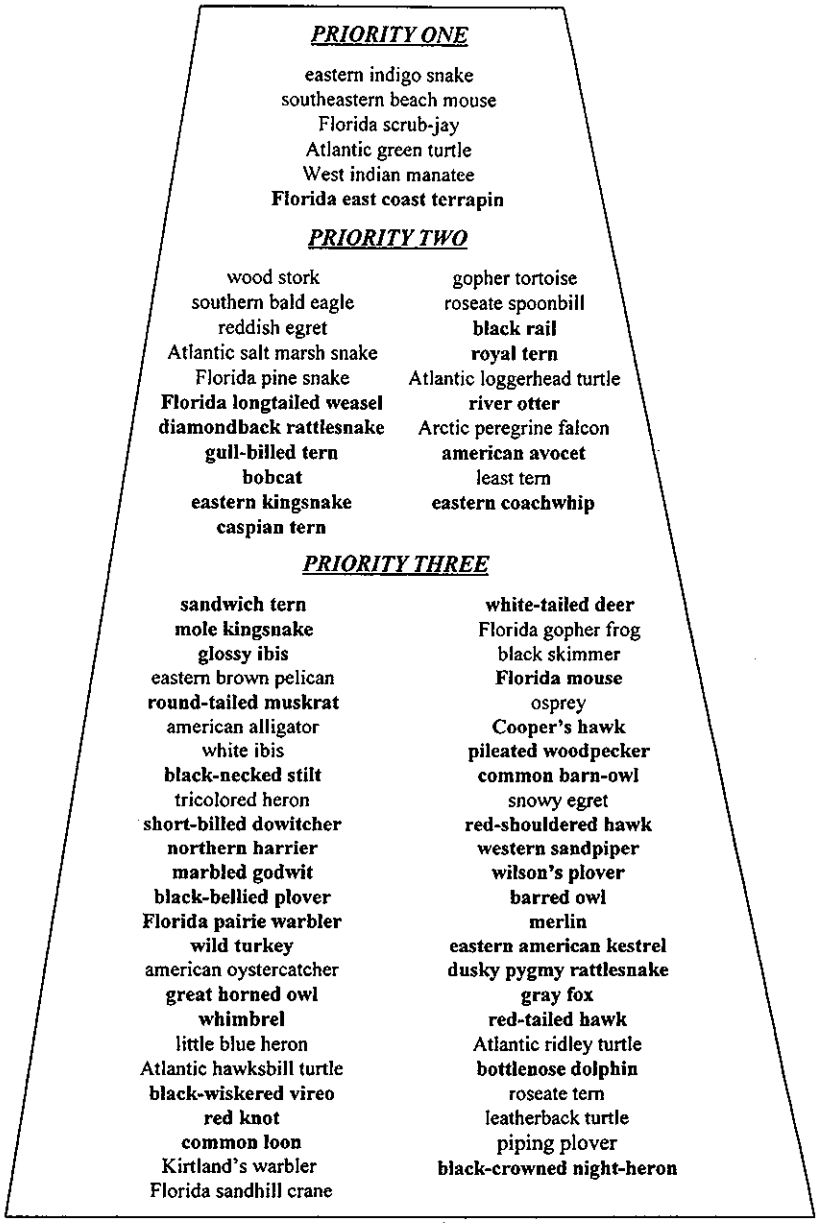

Figure 1. Monitoring priorities of potentially endangered wildlife taxa on John F. Kennedy Space Center, Florida. Taxa were scored based on their vulnerability to extinction, their potential role for maintaining faunal integrity, and the relevance of KSC for maintaining their populations in the United States and Florida. Taxa in bold were not listed by US Fish and Wildlife Service (USFWS) or Florida Game Fresh Water Fish Commission (FGFWFC). Taxa in priority one had the highest scores, which were between 195 and 148. Taxa in priority two had scores between 147 and 100. Taxa in priority three had scores between 99 and 52. Taxa in the fourth priority (not shown) had scores between 51 and 7.

tially isolated on KSC, and all but two had small population sizes.

Discussion

Many taxa were vulnerable to extinction at the local scale. The red-cockaded woodpecker, dusky seaside sparrow, Carolina parakeet, West Indian monk seal, ivory-billed woodpecker, Florida black bear, Florida panther, and Florida red wolf have already become extinct on KSC (Allen 1971, Cruickshank 1980). The loss of top predators may have caused an increase in mesopredators, such as raccoons, which have impacted other taxa. Predation, primarily by raccoons, of 60–99% of marine turtle nests on KSC was common until intensive raccoon management was employed (Provancha and Ehrhart 1987). Raccoon predation has been partially responsible for the demise of east coast diamondback terrapins (Seigel 1979, 1993). Gopher tortoises are vulnerable to an introduced respiratory disease (Smith unpublished data) and raccoon nest predation (Douglass and Winegarner 1977). The loss of gopher tortoises from the ecosystem could result in the loss of many other taxa because tortoise burrows provide refuge for at least 81 other taxa (Cox and others 1987).

Many top predators that remain at KSC (e.g., bobcat and river otter) may not be endangered in the United States but are endangered in many local landscapes because of small population sizes and road mortality (Harris 1984). The many bobcats and indigo snakes that have been found dead along KSC roads may have represented significant portions of the KSC populations of these two predators (Barkaszi and Smith unpublished data). We identified that almost all keystone taxa had low population sizes, making them vulnerable to extinction. Although KSC is not among the largest conservation lands in Florida, KSC is many times larger than the average conservation area (Cox and others 1994). The importance of remaining predators and other keystone taxa in maintaining faunal integrity has received little study. With much uncertainty, we listed several taxa as having keystone roles. The white-tailed deer, now rare at KSC, has a significant grazing impact in some ecosystems (Alverson and others 1988). Deer may have helped maintain openings, in scrub vegetation, that were important to other endangered taxa. Openings are now rare on KSC (Breininger and others 1995).

We found poorly known or secretive taxa that were vulnerable to global extinction but not listed by the USFWS, FGFWFC, or FNAI. The vulnerability of these taxa may not be addressed until they approach extinction (Humphrey and Barbour 1981). The east coast diamondback terrapin only occurs in east central Florida. The few large terrapin populations, known to exist for the last two decades, appear to have declined to a few individuals (Seigel 1993). East central Florida was important for breeding black rails and supported the most dense wintering population in the United States, but their habitat has been altered in a potentially detrimental manner (Sykes 1978, Root 1988). Most US population sizes of the black rail are low or unknown, yet the black rail is federally listed only in California (Eddleman and others 1988). Wilson's plovers were once locally abundant but are now rare (Cruickshank 1980). There are only 196 records of the long-tailed weasel in Florida; none were captured during 4493 trap nights in a recent survey (Hovis 1992). The long-tailed weasel was known to occur on KSC only from two road kills.

The largest global populations of the Florida scrub jay and southeastern beach mouse occur on KSC/CCAS (Extine and Stout 1987, Breininger and others 1994). KSC aggregations of the West Indian manatee during spring comprise nearly ¼ of the US manatee population (Provancha and Provancha 1988). The second largest nesting population of loggerhead sea turtles, worldwide, occurs along east central Florida's coast (Provancha and Ehrhart 1987).

Compelling arguments can be made for conservation that does not focus only on taxa vulnerable to global extinction (Hunter and Hutchinson 1994). Many taxa will become endangered without conservation at the local scale. Although KSC may not have largest populations of many taxa, it provides for significant populations of many taxa in the southeastern US that have restricted habitat availability. KSC waterbird colonies could become critical because breeding colonies are dynamic; many population centers are needed to minimize extinction risk associated with catastrophes and changing environments (Bildstein and others 1991). Waterbird feeding and nesting habitats are disjunct in management jurisdiction and are influenced by hurricanes, freeze damage to nesting areas, rainfall patterns, and water management practices (Schreiber and Schreiber 1978, Breininger and Smith 1990, Smith and Breininger 1995).

Conspecific taxa or taxa with similar functional roles are better targets for monitoring than some federally listed taxa (Noss 1990). Atlantic ridleys, Atlantic hawksbills, leatherbacks, Atlantic salt marsh snake, roseate terns, piping plovers, and Kirtland warblers are rare on KSC (Cruickshank 1980, Herbard and Lee 1981, Provancha and Ehrhart 1987). Some taxa listed by similar scientific assessments for Florida included species that are also of little concern at KSC. Most warblers, classified as vulnerable to extinction in Florida, have portions of their breeding range in north Florida (Kale 1978, Noss and Labisky 1990). Most members of these taxa that migrate through KSC are probably not from populations listed as vulnerable to extinction in Florida.

Our goals were to consider broad objectives of biological diversity for an initial screening based on limited data. Similar approaches can be tailored to assist in establishing management and monitoring priorities within other conservation areas or to assist in establishing priorities when comparing alternative sites for land acquisition. Taxa achieving high priorities from initial rankings need more accurate evaluations of extinction risk using data-intensive methods that consider demographic processes (Burgman and others 1993).

Conservation requires consideration of natural processes that maintain biological diversity and not only the composition of taxa (Noss 1990). Many of these processes do not occur as they did before human landscape modification. Prescribed burning is needed to maintain many KSC taxa because of fuel discontinuities resulting from habitat degradation and fragmentation (Breininger and Schmalzer 1990; Breininger and others 1995). Man-made habitats, such as impoundments, ditches,

and spoil islands have substituted for the loss of natural habitats for some colonial waterbirds, but these require intensive management (Schreiber and Schreiber 1978).

Conclusions

Lists by agencies and conservation organizations can be insufficient to identify many taxa vulnerable to extinction at the local scale. Complete scientific literature reviews are needed to identify taxa of conservation concern and to assess whether an area is critical for the survival of taxa. The identification of "hot spots" in biological diversity, such as KSC, is important (DeFreese 1995). Many taxa that are not globally vulnerable are at risk of local extinction. These include taxa that require large areas, have limited dispersal opportunities, or with narrow habitat tolerances. The loss of predators has unknown consequences concerning biological diversity, faunal integrity, and the adaptation and evolution of native habitats. The presence or protection of habitat is no longer sufficient for many populations, and habitats are dependent on active management due to ecosystem fragmentation and other disruptions of natural processes. Many taxa (e.g., wading birds, bobcats, river otters) occur as small populations within a region and their persistence depends on the success of the entire regional population. More direct and active involvement at the local scale is needed for successful management and acquisition efforts in order to conserve biological diversity (DeFreese 1995).

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Appendix 1. Common and scientific names for potentially endangered wildlife on John F. Kennedy Space Center, Florida, listed in decreasing order of priority

Eastern indigo snake (*Drymarchon corais couperi*)
Southeastern beach mouse (*Peromyscus polionotus niveiventris*)
Florida scrub-jay (*Aphelocoma coerulescens*)
Atlantic green turtle (*Chelonia mydas mydas*)
West Indian manatee (*Trichechus manatus latirostris*)
Florida east coast terrapin (*Malaclemys terrapin tequesta*)
Wood stork (*Mycteria americana*)
Gopher tortoise (*Gopherus polyphemus*)
Southern bald eagle (*Haliaeetus leucocephalus leucocephalus*)
Roseate spoonbill (*Ajaia ajaja*)
Reddish egret (*Egretta rufescens rufescens*)
Black rail (*Laterallus jamaicensis jamaicensis*)
Atlantic salt marsh snake (*Nerodia fasciata taeniata*)
Royal tern (*Sterna maximus*)
Florida pine snake (*Pituophis melanoleucus mugitus*)
Atlantic loggerhead turtle (*Caretta caretta caretta*)
Florida long-tailed weasel (*Mustela frenata peninsulae*)
River otter (*Lutra canadensis vaga*)
Eastern diamondback rattlesnake (*Crotalus adamanteus*)
Arctic peregrine falcon (*Falco peregrinus tundrius*)
Gull-billed tern (*Sterna nilotica*)
American avocet (*Recurvirostra americana*)
Bobcat (*Lynx rufus floridanus*)
Least tern (*Sterna antillarum antillarum*)
Eastern kingsnake (*Lampropeltis getulus getulus*)
Eastern coachwhip (*Masticophis flagellum flagellum*)
Caspian tern (*Sterna caspia*)
Sandwich tern (*Sterna sandvicensis*)
White-tailed deer (*Odocoileus virginianus*)
Mole kingsnake (*Lampropeltus calligaster rhombomaculata*)
Florida gopher frog (*Rana capito aesophus*)
Glossy ibis (*Plegadis falcinellus falcinellus*)
Black skimmer (*Rynchops niger*)
Eastern brown pelican (*Pelecanus occidentalis carolinensis*)
Florida mouse (*Podomys floridanus*)
Round-tailed muskrat (*Neofiber alleni*)
Osprey (*Pandion haliaetus carolinensis*)
American alligator (*Alligator mississipiensis*)
Cooper's hawk (*Accipiter cooperii*)
White ibis (*Eudocimus albus*)
Pileated woodpecker (*Dryocopus pileatus pileatus*)
Black-necked stilt (*Himantopus mexicanus mexicanus*)
Common barn-owl (*Tyto alba pratincola*)
Tricolored heron (*Egretta tricolor ruficolis*)
Snowy egret (*Egretta thula thula*)
Short-billed dowitcher (*Limnodramus griseus griseus*)
Red-shouldered hawk (*Buteo lineatus alleni and extimus*)
Northern harrier (*Circus cyaneus hudsonius*)
Western sandpiper (*Calidris mauri*)
Marbled godwit (*Limosa fedoa*)
Wilson's plover (*Charadrius wilsonia wilsonia*)
Black-bellied plover (*Pluvius squatarola*)
Barred owl (*Strix varia georgia*)
Florida prairie warbler (*Dendroica discolor paludicola*)
Merlin (*Falco columbarius columbarius*)

Appendix 1 (Continued). Common and scientific names for potentially endangered wildlife on John F. Kennedy Space Center, Florida, listed in decreasing order of priority

Wild turkey (*Meleagris gallopavo osceola*)
Eastern American kestrel (*Falco sparverius sparverius*)
American oystercatcher (*Haematopus palliatus palliatus*)
Dusky pygmy rattlesnake (*Sistrurus miliarius barbouri*)
Great horned owl (*Bubo virginianus virginianus*)
Gray fox (*Urocyon cinereoargenteus floridanus*)
Whimbrel (*Numenius phaeocopus hudsonicus*)
Red-tailed hawk (*Buteo jamaicensis borealis and umbrinus*)
Little blue heron (*Egretta caerulea*)
Atlantic ridley turtle (*Lepidochelys kempi*)
Atlantic hawksbill turtle (*Eretmochelys kempii*)
Bottlenose dolphin (*Tursiops truncatus*)
Black-wiskered vireo (*Vireo altiloquus*)
Roseate tern (*Sterna dougallii*)
Red knot (*Calidris canutus rufa*)
Leatherback turtle (*Dermochelys coriacea coriacea*)
Common loon (*Gavai immer*)
Piping plover (*Charadrius melodus*)
Kirtland's warbler (*Dendroica kirtlandii*)
Black-crowned night-heron (*Nycticorax nycticorax hoacti*)
Florida sandhill crane (*Grus canadensis pratensis*)
Red-headed woodpecker (*Melanerpes erythrocephalus erythrocephalus*)
Swallow-tailed kite (*Elanoides forficatus forticatus*)
Mottled duck (*Anas fulvigula fulvigula*)
Loggerhead shrike (*Lanius ludovicianus*)
Louisiana waterthrush (*Seiurus motacilla*)
Common ground-dove (*Columbina passerina*)
Least bittern (*Ixobrychus exilis exilis*)
Sooty tern (*Sterna fuscata*)
Sanderling (*Calidris alba*)
Southeastern kestrel (*Falco sparverius paulus*)
Magnificant frigatebird (*Fregata magnificens rothschildi*)
King rail (*Rallus elegans elegans*)
Worm-eating warbler (*Helmintheros vermivorus*)
Great egret (*Casmerodius albus egretta*)
Great white heron (*Ardea herodias occidentalis*)
Limpkin (*Aramus guarauna pictus*)
Yellow-crowned night-heron (*Nyctanassa violaceus violaceus*)
Pectoral sandpiper (*Calidris melanotos*)
Hairy woodpecker (*Picoides villosus audubonii*)
Semipalmated sandpiper (*Calidris pusilla*)
White-rumped sandpiper (*Calidris fuscicollis*)
Burrowing owl (*Athene cunicularia floridana*)
Swainson's hawk (*Buteo swainsoni*)
Bachman's sparrow (*Aimophila aestivalis*)
Field sparrow (*Spizella pusilla*)
American black duck (*Anas rubribes*)
American bittern (*Botaurus lentiginosus*)
American redstart (*Setophaga ruticilla*)
Broad-winged hawk (*Buteo platypterus platypterus*)
Brown-headed nuthatch (*Sitta pusilla*)
Hooded warbler (*Wilsonia citrina*)
Kentucky warbler (*Oporomis formosus*)
Yellow-breasted chat (*Icteria virens*)

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